

## Comparison of Isometric Endurance of Abdominal and Back Extensor Muscles in Manual and Sedentary Males in the Age Group of 20-40 Years

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### ABSTRACT

**Background:** Stabilization of trunk flexors and extensors are essential for normal lumbo-pelvic function. These muscles, known as “core muscles”, have a basic role in balance and coordination in sitting. The core is the lumbo-pelvic-hip complex which includes lumbar spine, pelvis, hips, and their respective musculature. Pattern of core activity changes in sitting and dysfunction of core muscles increased the risk of damage of the upper and lower extremities segments. Powerful core muscles support stabilizes the vertebra and pelvis, prevents balance disorder and decreases the rate of LBP which is one of the most prevalent occupational disorders. Endurance of trunk muscles depends on the life style and working condition of individuals. Imbalance in the trunk muscle endurance secondarily leads to back pain, which disables the person and reduces the functional capacity of individuals.

**Objective:** The aim of this study is to evaluate the difference in isometric endurance between abdominal and back extensor muscle in manual and sedentary workers and guide them about the importance of endurance training in preventing the back pain in the future.

**Materials and methods:** This study includes 40 simple randomly sampled normal male subjects according to the inclusion and exclusion criteria in the age group of 20-40 years, recruited on voluntary basis and allotted to Group A (N=20, Manual workers) and Group B (N=20, Sedentary workers). Modified Kraus weber's test for abdominal muscles and Modified Sorensen's test for back extensor muscles were performed by both Group A and Group B in two successive trials for each test with a rest break of 3-5 minutes in between the trials and the best of trials in seconds is recorded with a stop watch and the data is analyzed using SPSS statistics software version 19.

**Results:** The isometric abdominal muscles endurance is more in manual workers than the sedentary workers, at a significance level of  $p < 0.005$ . The isometric endurance of back extensor muscles is more than isometric abdominal muscles in both the groups, at a significance level of  $p < 0.005$ . The isometric back extensor muscles endurance is more in manual workers than in sedentary workers, at a significance level of  $p < 0.005$ .

**Conclusion:** The isometric abdominal muscles endurance is less in both the groups as compared to isometric back extensor muscles endurance. So, abdominal muscles should be concentrated during endurance training. The objective of any fitness regime, maintenance of good health and posture and treatment of back pain is identifying

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dangerous causes that require immediate attention and attempt to prevent chronic low back pain problems. The modified Sorensen's and Kraus Weber's test can be used to assess and train the trunk muscles endurance as they are simple, easy, reliable and replace the costly and time consuming machine methods for evaluating and training endurance.

**Keywords:** Isometric; Endurance; Back extensors; Abdominals; Core strengthening; Trunk stability

## INTRODUCTION

Modern life has pushed human societies toward sedentary lifestyles [1,2]. A sitting lifestyle may be one of the most critical public health problems in the 21<sup>st</sup> century [3]. Due to the lower center of gravity and a wider base of support, sitting is a comfortable posture imposing low energy consumption [4]. Likewise, performing daily activities in a sitting position contributes to a sedentary lifestyle.

Those individuals who do not have any physical activity are in the non-moving or sedentary group [5]. The activities of energy expenditure between 1.0-1.5 METS (Multiples of the basal metabolic rate) are classified as sedentary behaviors [6]. Light intensity activity behaviours require expenditure of no more than 2.9 METs. Moderate-to-vigorous physical activity requires an energy expenditure of 3 to 8 METs. Medium to high level of activity are recommended for prevention and treatment of many chronic diseases [7]. A sedentary lifestyle increases the risk of musculoskeletal problems [5,6]. Maintaining the same position for extended periods may impose creep and deformation in soft tissues [8]; however, the duration of sustained positions to cause creep or deformation varies [9].

Stabilization of trunk flexors and extensors are essential for normal lumbopelvic function [10]. These muscles, known as "core muscles", have a basic role in balance and coordination in sitting [11]. The core is the lumbopelvic-hip complex which includes lumbar spine, pelvis, hips, and their respective musculature. On the other hand, core stability is critical for trunk and extremities movements as well [12]. Pattern of core activity changes in sitting [13,14] and dysfunction of core muscles increased the risk of damage of the upper and lower extremities segments [14]. Powerful core muscles support stabilizes the vertebra and pelvis, prevents balance disorders [11] and decreases the rate of LBP which is one of the most prevalent occupational disorders [15].

In the available literatures fixed prolonged sitting posture is a predisposing factor for LBP [16]. In a study in 2005 [17], trunk muscle endurance was significantly lower in LBP clients than healthy matched individuals, thus they recommended trunk muscle endurance as a predictor for individual's susceptibility to LBP. Another study in 2009 showed that people with standing jobs that require some sitting intervals were less exposed to LBP compared to those who were permanently working in standing [18]. The individuals who had to sit permanently were also more exposed to LBP compared to those who had the chance for movement and standing up in their work hours; that confirms the negative consequences of working in a fixed position [18].

The manual work is termed as "the work which needs continuous strenuous muscular efforts in which muscle has to work to its maximum strength and endurance. This work contains conditions like continuous standing, bending, rotation, lifting heavy weights etc." In all activities of daily living and working conditions, there is soft tissue strain resulting from sustain static posture like frequent lifting and twisting, prolonged sitting in one position [19-21].

Back and abdominal muscle shows continuous activity during standing, lifting, rotation, twisting [22], However while sitting, there is very minimal or no activity [13]. So, to protect the soft tissue strain and to sustain the posture, these muscles must have proper endurance. There is normal ratio of abdominal and back extensor endurance in normal individuals [21]. But, because of the working conditions and type of work there is difference in the abdominal and back muscle endurance in manual and sedentary workers.

A change in the muscle endurance performance leads to back pain and disability [23-27]. Several studies investigating the relationship between muscle endurance, back pain, and disability caused by this has already been done. Endurance of trunk muscles depends on the life style and working condition of individuals. Imbalance in the trunk muscle endurance secondarily leads to back pain, which disables the person and reduces the functional capacity of individuals. So, the objective of this study is to evaluate the difference in isometric endurance between abdominal and back extensor muscle in manual and sedentary workers and guide them about the importance of endurance training in preventing the back pain in the future.

## MATERIALS AND METHODS

### Study design and participants

Experimental study design with 40 healthy male participants, who reported as attendants to the ongoing treatment of their family members at Pandit Deendayal Upadhyay national institute for the persons with physical disabilities (Divyangjan), New Delhi, India within the age group of 20-40 years were recruited on voluntary basis and informed consent was obtained before the study and the participants were allotted to groups, Group A (20 Manual workers) and Group B (20 Sedentary workers). The inclusion criteria was individuals working in the said capacity for 3-5 years, manual workers who do manual work in continuous standing position for more than 4 hours per day and at least 5 days a week and sedentary workers who do office work involving sitting for more than 4 hours per day and at least 5 days a week. The exclusion criteria was history of back pain in the last 1 year, abdominal/gastric issues, any neurological,

cardiac, orthopedic and pulmonary diseases and any other disease that may interfere with the assessment.

**Equipment’s used**

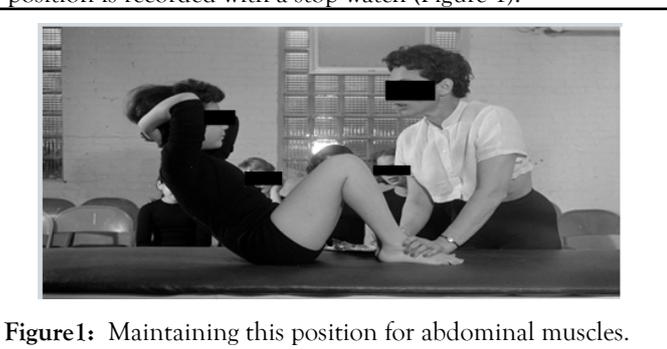
- Stopwatch
- Pillows and Towel rolls.
- Plinth and stabilizing straps

**Procedure**

The subjects included in this study were taken into confidence and good rapport was developed with each of them. The procedure was explained and demonstrated to each one of them. When procedure was well understood by each of them, the following tests were performed by both Group A and Group B and in two trials for abdominal muscles and back extensor muscles with a rest break of 3-5 minutes in between and the best of two trials is recorded for data analysis.

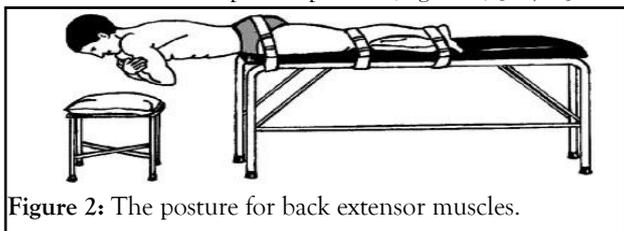
**Parameters studied**

**Modified Kraus weber’s test (For abdominal muscles):** Subject is in supine lying with hip and knee in 90° of flexion. Arm behind the head to support and maintain the neck in flexion without any undue discomfort. The subject is asked to do a curl up and hold the position midway between crook lying and crook sitting when ready, time taken in holding/ maintaining this position is recorded with a stop watch (Figure 1).



**Figure 1:** Maintaining this position for abdominal muscles.

**Modified Sorensen’s test (For back extensor muscles):** Subject lying prone with the trunk off the plinth with towel roll/ pillow support under the pelvis and legs to avoid pressure pain and after making the subject comfortable, strapping is done to secure the position of the subject and a stool with soft padding is placed in front of the plinth for hands to land during the termination of the test or for emergency stoppage of the test, the subject is asked to maintain steady horizontal state when ready and time taken in holding/ maintaining this position is recorded with the help of stopwatch (Figure 2) [28,29].



**Figure 2:** The posture for back extensor muscles.

**Protocol followed**

During the above procedure the subjects were asked to maintain cervical flexion and pelvic stabilization through gluteal muscle contraction. The cervical and pelvic alignment proved to be the most optimal posture not only for decreasing lumbar lordosis but also activating trunk flexors and extensors.

Subjects are advised to avoid Valsalva maneuver during this test.

The criteria for the termination of the tests are pain and fatigue.

The holding time is recorded in seconds with the help of stopwatch.

Data collected and analyzed using IBM SPSS statistics software Version 19 to measure the statistical values of static endurance between abdominal muscles and back extensor muscles in manual and sedentary workers.

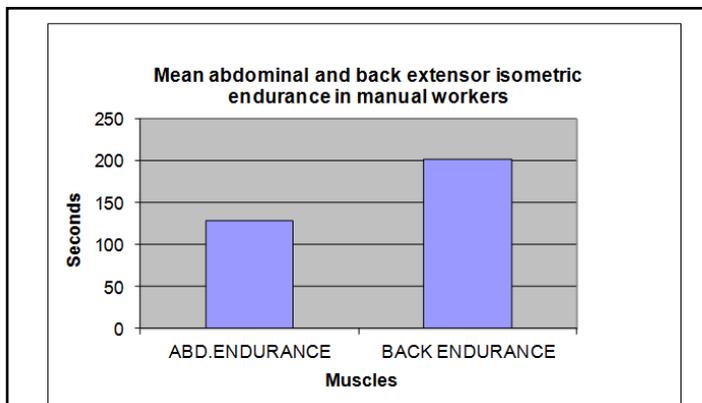
**Statistical analysis**

Individual’s characteristics are presented as means ± standard deviations. The unpaired t-test using SPSS software version 19.0 with a two-tailed significance with p-value of <0.005 (Table 1) (Figures 2-5).

Group-A	Age (Years)	Isometric endurance	Mean (Sec)	S.D.	Diff(Sec)	t-value
Manual workers	20-40 (30 ± 6.37)	Abdominal muscles	128.5	15.7	73.15	-0.005
		Back extensor muscles	201.65	55.72		5.19 (E-06)

Significant

**Table 1:** Difference of isometric abdominal muscles and back extensor muscles in manual workers.



**Figure 3:** Mean abdominal and back extensor isometric endurance in manual workers.

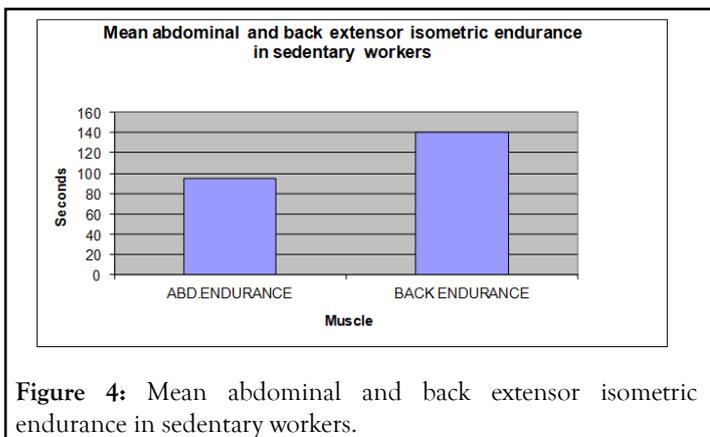
The mean and SD of isometric abdominal muscles endurance is (128.5 ± 15.70) seconds. The mean and SD of isometric back extensor muscles of spine endurance is (201.65 ± 55.72) seconds. The difference of endurance between isometric abdominal muscles and isometric back extensor muscle of spine is 73.15 seconds which shows that endurance of isometric back extensor of spine is more than endurance of isometric abdominal muscles (Table 2).

Unpaired t-test, comparing the significance with t-value of 5.19 (E-06) is highly significant at p<0.005 level.

Group-B	Age (Years)	Isometric endurance	Mean(Sec.)	S.D.	Diff. (Sec.)	t-value
Sedentary workers	20-40 (30 ± 6.37)	Abdominal muscles	94.44	21.72	46.17	-0.005
		Back extensor muscles	140.61	22.69		2.94 (E-06)

Significant

**Table 2:** Difference of isometric abdominal muscles and back extensor muscles in sedentary workers.



**Figure 4:** Mean abdominal and back extensor isometric endurance in sedentary workers.

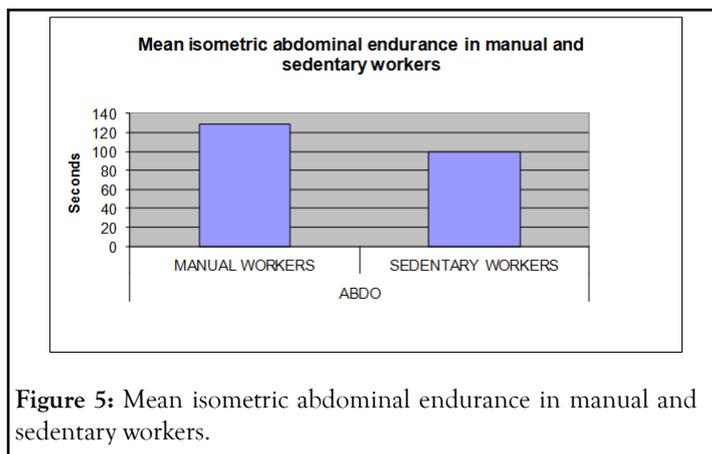
The mean and SD of isometric abdominal muscles endurance is (94.44 ± 21.72) seconds. The mean and SD of isometric back extensor muscles of spine endurance is (140.61 ± 22.69) seconds. The difference between isometric abdominal muscle endurance and isometric back extensor muscle endurance in sedentary workers is 46.17 sec, which shows that the endurance of back extensors muscles is more than abdominal muscles in sedentary workers.

Unpaired t-test comparing the significance with t-value of 2.94 (E-06) is highly significant at p<0.005 level (Table 3) (Figure 4).

Abdominal muscles	Groups	Age (years)	Mean (Sec.)	S.D.	Diff (Sec.)	t-value
	Manual workers	20-40 (30 ± 6.37)	128.5	16.84	29.1	Significant

workers	Age	Mean	S.D.	Diff	t-value
Sedentary workers	20-40 (28.1 ± 5.3)	99.4	26.56	3.76 (E-05)	

**Table 3:** Difference of isometric abdominal muscles in manual workers and sedentary workers.



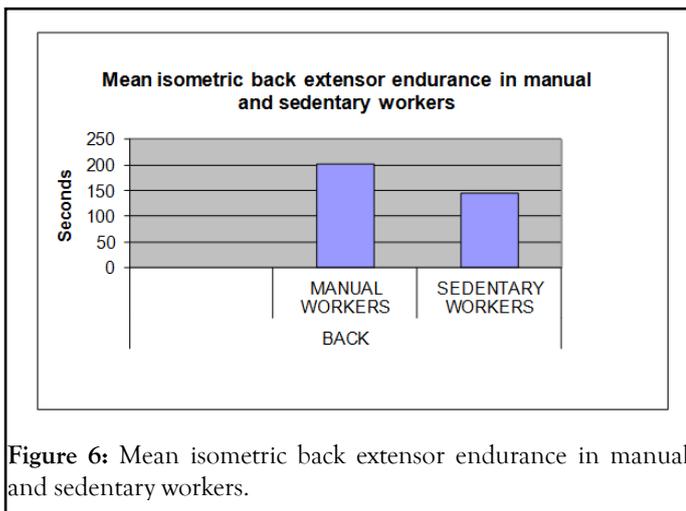
**Figure 5:** Mean isometric abdominal endurance in manual and sedentary workers.

The mean and SD of isometric abdominal muscles endurance in manual workers is (128.5 ± 16.84) seconds. The mean and SD of isometric abdominal muscles endurance sedentary worker is (99.44 ± 26.56) seconds. The difference of isometric abdominal muscle endurance between manual and sedentary workers is 29.1 seconds which shows that the isometric endurance of abdominal muscles is more in manual workers than sedentary workers.

Unpaired t-test comparing the significance with t-value of 3.76 (E-05) is highly significant at p<0.005 level (Table 4) (Figure 6).

Back extensor muscles	Groups	Age (years)	Mean (Sec.)	S.D.	Diff (Sec.)	t-value
	Manual workers	20-40 (30 ± 6.37)	202.35	60.03	58.59	4.65 (E-05)
	Sedentary workers	20-40 (28.1 ± 5.3)	143.76	23.86		Significant

**Table 4:** Difference of isometric back extensor muscles in manual workers and sedentary workers.



**Figure 6:** Mean isometric back extensor endurance in manual and sedentary workers.

## RESULTS AND DISCUSSION

The isometric abdominal muscles endurance is more in manual workers than the sedentary workers, at a significance level of  $p < 0.005$ .

The isometric endurance of back extensor muscles is more than isometric abdominal muscles in both the groups, at a significance level of  $p < 0.005$ .

The isometric back extensor muscles endurance is more in manual workers than in sedentary workers, at a significance level of  $p < 0.005$ .

Tables 1 and 2 and Figures 2 and 3 shows that the endurance of isometric back extensor muscle is more than the isometric endurance of abdominal muscles in both groups and it is highly significant. During manual work, generally there is activity of both abdominal muscles and back extensor muscles. But, back extensor muscles are postural muscles, so they act continuously and maximally with recruitment of all fibers. While abdominal muscles act very minimally during this situation and maximally in straining work during manual work [29-31].

Liebenson suggested that modern sedentary life style has an impact on the development of muscular dysfunction. A tendency is seen towards overuse of postural muscles because of prolonged constrained postures during sitting. Phasic muscles on the other hand tend to become inhibited and weak, because of disuse and de-conditioning. Modern societies emphasize on constrained postures and sedentary lifestyle promotes an imbalance between overactive and inhibited muscles. Also in sedentary work, there is no activity of abdominal muscles seen as compare to spinal extensor muscles there is no recruitment of fibers seen in abdominal muscles. Because of disuse of abdominal muscles, the antagonistic back muscles become stronger by overuse. Thus, there is protrusion of abdomen with compensated lumbar lordosis is seen in sedentary workers.

Table 3 and Figure 4 shows that isometric abdominal muscle endurance is more in manual workers than in sedentary workers. This may be due to straining activities in manual work, there is more number of fibers recruitment as there is more activity of abdominal muscles to increase in intra-abdominal pressure to stabilize the spine and abdominal contents (spatially inguinal canal). So, their endurance will be more. But, in

sedentary work, there is no or very minimal activity of abdominal muscles. So, its endurance will be decreased [32].

Table 4 and Figure 5 shows that endurance of isometric back extensor muscles is more in manual workers than sedentary workers. In manual work, there is more number of recruitment of muscle fibers seen because of straining activity (as back muscles acts more as tonic i.e. postural muscles as well as work to bear extra load). In this, there is recruitment of type-I and type-IIa and IIb muscles seen. So, its endurance will be more. However, in sedentary work, back extensor muscles acts only as tonic muscles. Also, there is no recruitment of extra number of muscle fibers as there is no extra load to recruit them. So, its endurance will be less as compare to manual workers.

Low back pain is a well-recognized major cause of disability in the industrialized world with multi factorial etiology. Spine endurance and stabilization exercises are most commonly prescribed by professionals for the rehabilitation and prevention of low back injuries. Diminished trunk extensor muscle endurance is linked to low back trouble as endurance plays a significant role in back health rather than strength which has a very weak relationship with back health in normal subjects. These mean scores and ratios can be used as a guideline to recognize muscle dysfunction and also to anticipate low back pain occurrence in the future.

The lumbar stability is obtained through both the concomitant increase in muscle co-activation of back extensor muscles and abdominal muscles and for this both muscles groups needs good endurance. An imbalance in trunk muscle endurance can influence significant lordotic curve of lumbar spine and might be one of the risk factor for potential low back pain. Endurance of both muscles groups is important to maintain the stability of spine, restore the function and prevent the disability due to back pain.

## CONCLUSION

The isometric abdominal muscles endurance is less in both the groups as compare to isometric back extensor muscles endurance. So, abdominal muscles should be concentrated during endurance training. The objective of any fitness regime, maintenance of good health and posture and treatment of back pain is identifying dangerous causes that require immediate attention and attempt to prevent chronic low back pain problems. The modified Sorensen and Kraus Weber test can be used to assess and train the trunk muscles endurance as they are simple, easy, reliable and replace the costly and time consuming machine methods for evaluating and training endurance and can be performed anywhere and also without spatial supervision.

## LIMITATIONS AND SUGGESTIONS FOR FURTHER RESEARCH

As the modified Sorensen and Kraus Weber test for evaluating the isometric endurance of back extensor and abdominal muscles are simple, easy to perform and reliable, they can be used as preventive measure for low back pain and disability

associated with them. Persons with age group more than 40 years could be studied with more number of male and female subjects to further validate the findings of the study. The effectiveness of training may be found out by taking pre-training and post-training endurance values for the given training period. Age, gender, BMI, Personal habits, emotional status and diurnal variations all these factors has effect on endurance. So, all these factors can be taken into account while evaluating the endurance. Future studies can be conducted on subjects with sedentary lifestyle with and without low back pain in different BMI groups by employing ultrasound imaging techniques and exploring trunk muscle thickness.

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## CONFLICT OF INTEREST

The authors declared no conflicts of interest with respect to the authorship and/or publication of this article.

## ETHICAL APPROVAL

Approved.

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